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DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
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H-3-39

February 14, 1977

MEMO TO: G. F. Kemper
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report 467; "Voidless and Internally Sealed Concretes (Construction Report; Silas Creek Bridge, US 27, MP-009-0027-B0002);" KYP-72-39; HPR-PL-1(12), Part III-B.

Planned modifications in the concrete for two spans of the bridge were aborted after the casting began and after recognition of early loss of slump and workability of concrete. Whereas, the desired consistency was achieved in the mixing drum, without difficulty, working time was extremely short. Had it been possible to have regurgitated the mixture from the drum immediately and to have deposited it directly in place on the deck in front of an advancing screed, the work could have been accomplished as planned. Otherwise, only equipment capable of handling and finishing no-slump concrete would have sufficed. We chose not to use retarders because there is always a tendency to move more slowly when more working time is allowed. There were unnecessary delays in handling the PVP and Melment concretes; but on the other hand, we were hopeful that the contractor's normal procedures would suffice. Consequently, demonstration of low-voids concrete in decks remains to be achieved; and opportunities to carry through a more deliberate plan of concreteing will be sought on future projects.

Although it is not mentioned in the report, laboratory trials of wax beads first recieved indicated that the wax damaged the concrete upon heating to the melting temperature. Apparently, the greater thermal expansion of the wax induced severe internal pressures and caused internal cracks. When this observation was called to the attention of the FHWA sponsors, it was found that the damage could be prevented by entraining about 5% air in the wax. Our shipment of wax beads was returned to the manufacturer and replaced with the qualifying material. The addition of the wax beads to the concrete was accomplished easily. The heating was accomplished satisfactorily also. How effectively the concrete was sealed (internally) remains to be determined. Microscopic examination showed that the wax beads had melted and had wetted and was absorbed into the mortar -- leaving spherical cavities. This was apparent to a depth of about 3/4 inch. Wax beads at greater depths may have melted but did not wet the internal surfaces sufficiently to be absorbed. Coating and re-solidification may have restored them to their original shape and condition.

Observations will continue indefinitely, and findings of significance will be reported.

Respectfully submitted,

Jas. H. Havens
Director of Research

JHH:gd
Enc.
cc's: Research Committee
Howard Warner

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16. Abstract

Laboratory investigations on concretes containing super water reducers, PVP and Melment, indicated their suitability for field utilization. Wax beads have been used by other states in concretes for bridge slabs. This report describes the reconstruction of a four-span bridge having three experimental slabs and one conventional slab. Post-construction analyses of cores are included.

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Research Report
467

VOIDLESS AND INTERNALLY SEALED CONCRETES
(Construction Report; Silas Creek Bridge, US 27,
MP-009-0027-B0002)

KYP-72-39, HPR-PL-1(12), Part III-B

by

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Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

February 1977

INTRODUCTION

The high incidence of deterioration of concrete in bridge decks has been attributed, by some, to uses of de-icing salts. Several investigators have associated salts in excess of 2 pounds per cubic yard (1.18 kg/m^3) of concrete with rusting of the reinforcing steel and spalling of the overlying concrete. Inadequate thickness of concrete over the steel and porosity and permeability of the concrete itself are offending factors. Several factors contributing to the bridge deck durability problem are under study by various state and federal agencies. Apparent solutions fall into three, rather broad categories: (1) alter or protect the concrete to prevent the intrusion of salts, (2) alter or protect the steel reinforcement to prevent corrosion even in the presence of high concentrations of salt, and (3) densify or otherwise limit the water-absorbing capacity of concrete to improve resistance to freeze and thaw. Some of the remedies are epoxy-coated reinforcement, galvanized reinforcement, cathodic protection, waterproofing membranes, latex-modified concrete, low-slump concrete, concrete containing wax beads, and no-void concrete. Some of these potential solutions have been tried and are in various stages of development and proof testing.

This report describes the reconstruction of a four-span bridge on US 27 over Silas Creek on the Bourbon-Harrison County line (Figure 1). The original deck (Figure 2), curbs, and plinth were to be removed; and the beams, girders, and substructure were to be salvaged. Plans for reconstruction of the bridge specified one span to be constructed of Class AA Concrete (conventional or control slab) and the other three slabs to contain experimental features: one to contain wax beads, and each of the remaining slabs to contain one of two, super water-reducing admixtures. Extensive laboratory tests had been conducted on each of the experimental concretes. Wax beads in concrete had been used in decks in some other states; only very limited field applications had been attempted for concretes containing high dosages of the super water-reducers.

RECONSTRUCTION DETAILS

General

This bridge was constructed in 1948 and accepted from the contractor on September 25, 1948. There were four, simply supported, reinforced concrete, deck-girder spans, each 35 feet (10.67 m) long and 26 feet (7.92 m) wide. The deck remained virtually maintenance free until the late 1960's when it started deteriorating progressively and required periodic patching. The deck was overlaid with epoxy mortar in 1968-69. By 1975, however, the deck had deteriorated to the point where total replacement of the deck was considered essential (Figures 3 and 4). Existing concrete girders were considered suitable for future use (Figure 5) and the stirrup reinforcement was specified to be cleaned and reshaped for use in bonding to the proposed replacement concrete slab. The original slab was 7 inches (177.8 mm) thick; the plan thickness of the new slab was 8 inches (203.2 mm) with 2 1/2 inches (63.5 mm) minimum cover above the top mat of reinforcement.

At the time of preparation of plans for restoration of the deck, extensive laboratory tests on "no-void" or "voidless" concrete were near completion. In addition, the FHWA had requested several states to incorporate wax beads into concrete on an experimental basis. The Silas Creek Bridge was considered an ideal structure for the experimental concretes; Special Notes (Appendix A) were prepared and attached to the proposal for the project. A contract for work was awarded March 30, 1976, to the Martin and Judy Construction Company; and work began April 26, 1976.

Experimental Concretes

Special notes for reconstruction of the bridge specified Class AA Concrete (Table 1), control section, in Span 1 and experimental concretes in Spans 2, 3, and 4. The concrete for Span 2 was specified to be Class AA Concrete to be modified by the substitution of 2 cubic feet (0.057 m^3) solid volume, of wax beads for 2 cubic feet (0.057 m^3), solid volume, of fine aggregate per cubic yard (0.76 m^3) of concrete. The wax beads were supplied by the Interpace Corporation, Alpco Products, at a cost of 64.6 cents per pound ($1.42 per kg). The beads were nearly spherical; 100 percent passed the 20-mesh screen; and no more than 5 percent passed the 80-mesh screen. The beads were dark brown and were a blend of 25 percent Montan wax and 75 percent paraffin, by weight. The wax beads were mixed into the fresh concrete. After Span 2 cured, the concrete was to be heated to melt the wax and seal the voids.

Concretes for Spans 3 and 4 were basically Class AA which was modified by the addition of super water-reducing admixtures (Table 2). An admixture referred to as PVP, supplied by John H. Hoge, Cincinnati, Ohio, at the cost of $1.10 per pound ($2.42 per kg) was to be used for all concrete placed in the deck of Span 3. PVP is a soluble powder and may be added to concrete in an aqueous solution of 25 to 50 percent PVP, by weight. Melment L-10 supplied by American Admixtures, Chicago, Illinois, at the cost of $2.95 per gallon (0.004 m^3) was to be used in the concrete in Span 4. Mehnent L-10 is a water-soluble

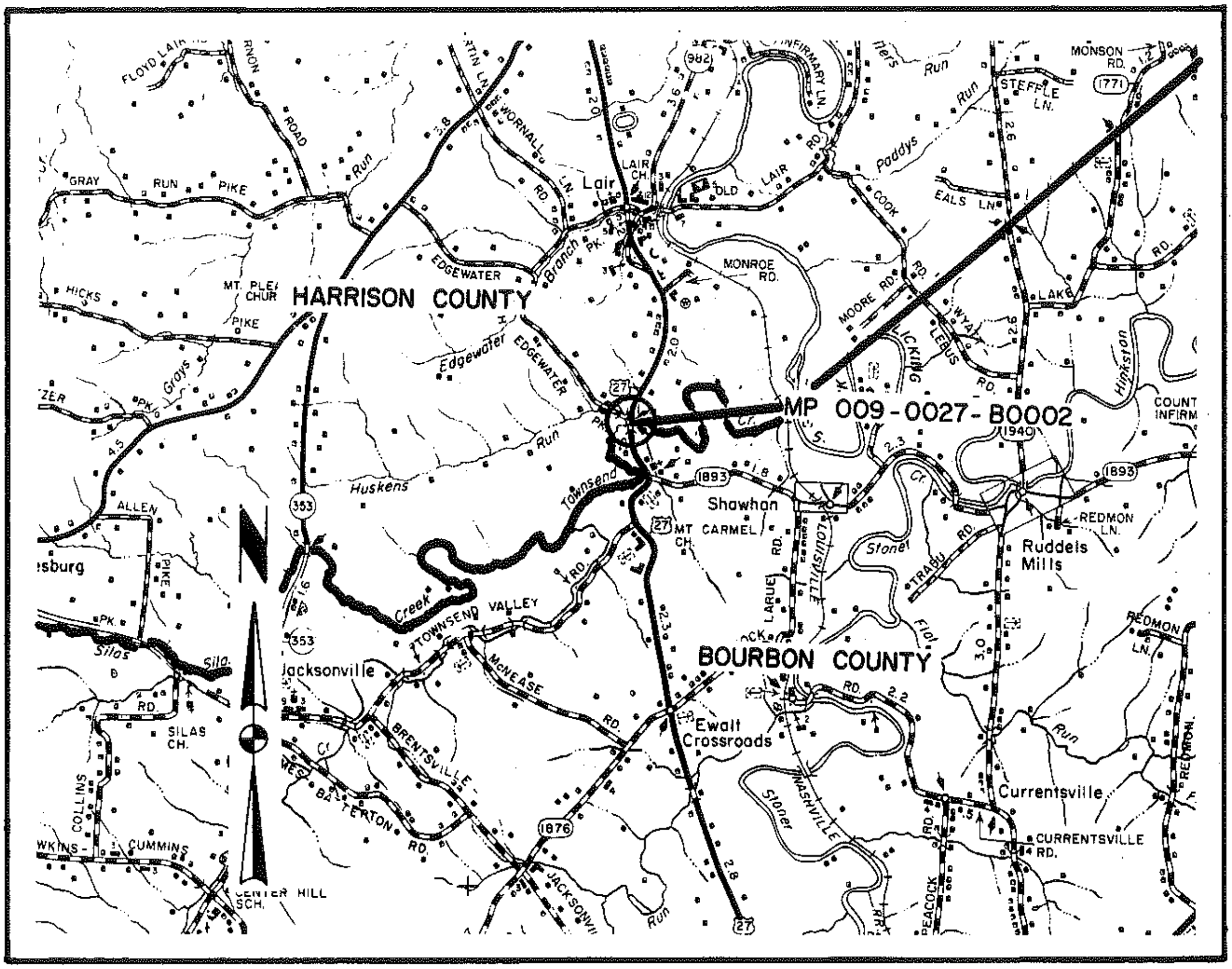


Figure 1. **Location of the US 27 Bridge Deck over Silas Creek, Bourbon-Harrison County Line.**

Figure 2. View of the US 27 Bridge over Silas Creek before Reconstruction.

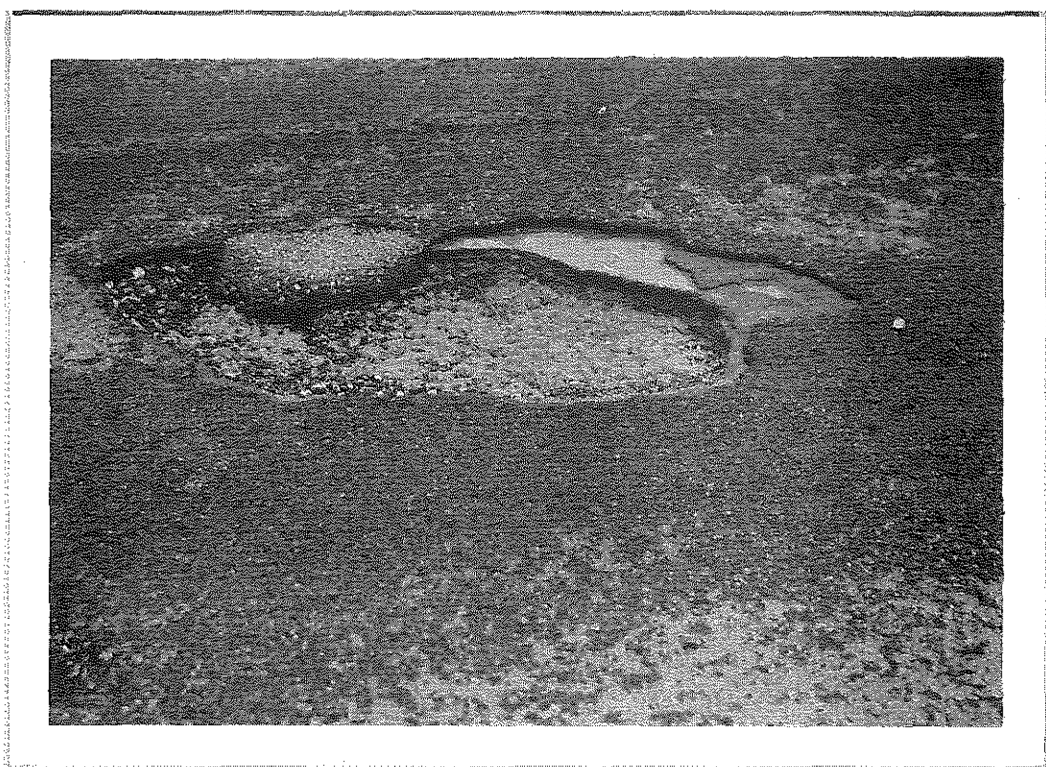
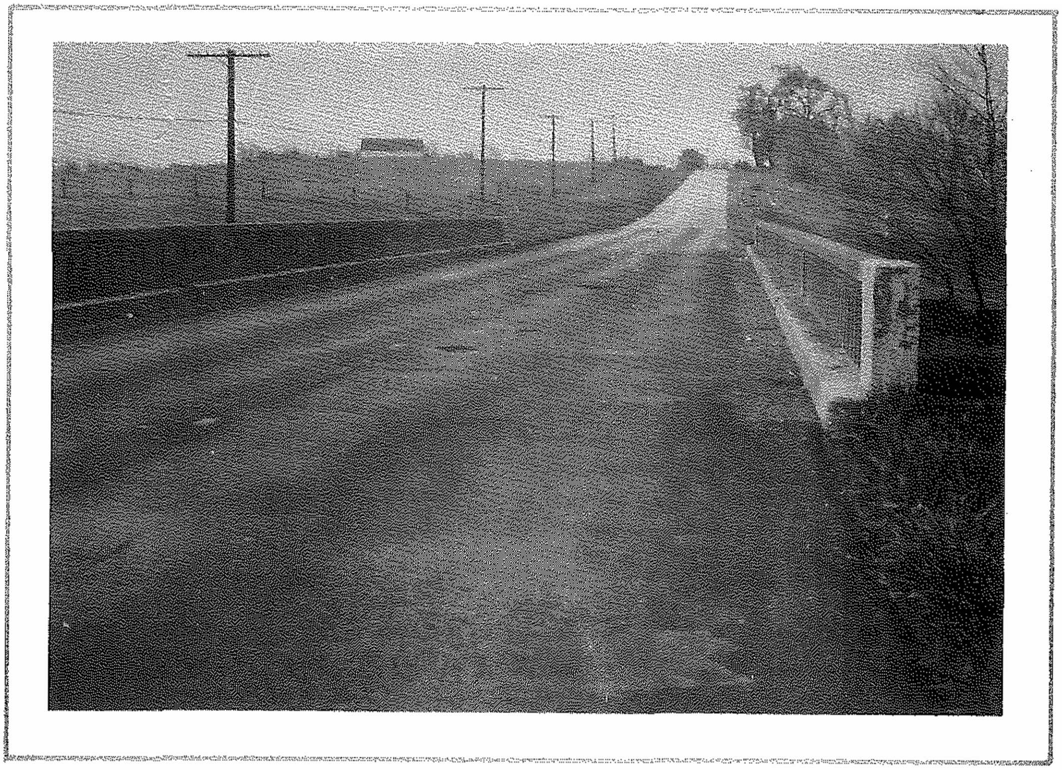


Figure 3. Deterioration of the Underlying Concrete Exposing the Reinforcing Steel.

Figure 4. View of the Deck Showing Numerous Pot-Holes.



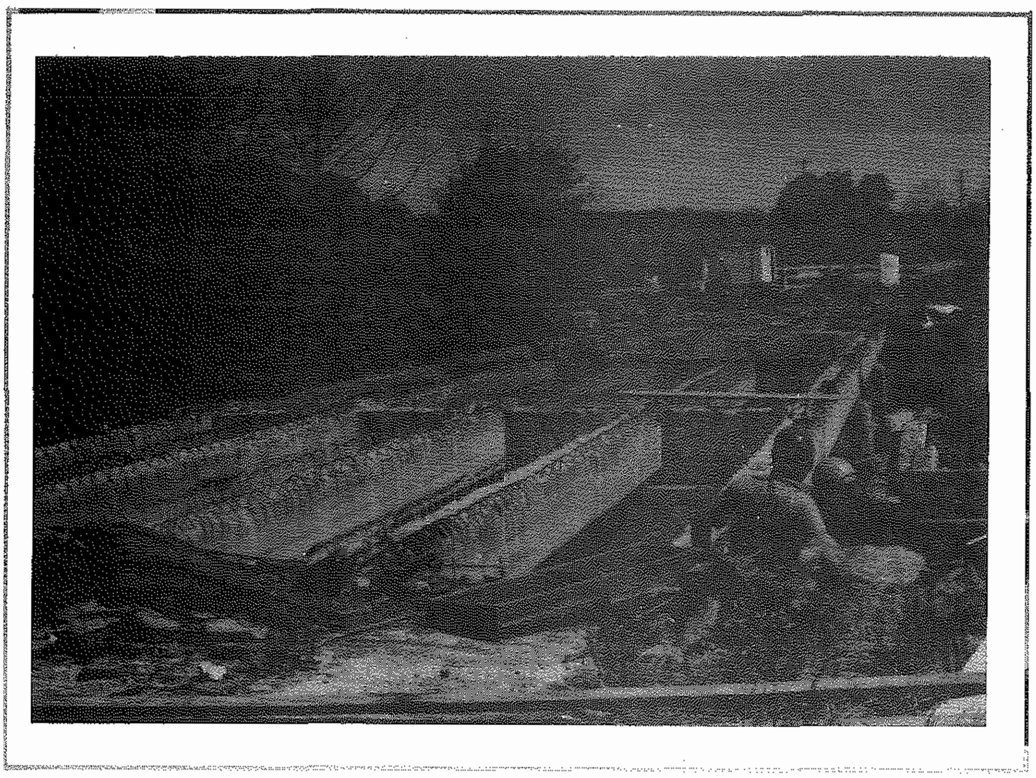


Figure 5. Remaining Girders Used for Reconstructing the Bridge Deck.

TABLE 1. CLASS AA MIX DESIGN

ITEM	MAGNITUDE lb/yd³	kg/m³
Cement	620	368
Water	275	163
Coarse Aggregate	1814	1076
Fine Aggregate	1196	710
Air Content	6%	6%
Slump	1 1/2 - 2 1/2"	38 - 64 mm
Approximate Average 28-Day Compressive Strength	4,500 psi	38,027 kPa
Flexural Strength (minimum)	275 psi	3,968 kPa

TABLE 2. EXPERIMENTAL CONCRETE MIX DESIGNS

	WAX BEADS		PVP		MELMENT	
ITEM	lb/yd³	kg/m³	lb/yd³	kg/m³	lb/yd³	kg/m³
Cement	620	368	620	368	620	368
Water	275	163	168	163	171	163
Coarse Aggregate	1957	887.7	1938	879.0	1938	879.0
Fine Aggregate	954	432.7	1273	577.4	1273	577.4
Additive	117	53	30	13.6	18.6	8.4
Air Content (%)	0	0	6	6	6	6
Slump	3"	76.2 mm	3"	76.2 mm	3"	76.2 mm

plasticizer. Laboratory tests on concretes produced with the admixtures indicated that workable mixtures could be expected using a water-cement ratio of approximately 0.30. The maximum permissible water-cement ratio for Class AA Concrete is 0.44.

The intent of using the water-reducers was to produce workable concrete mixtures containing a minimum of potentially harmful water. A water-cement ratio of approximately 0.24 is required for the hydration of normal portland cement. Any water in excess of that required for hydration is allowed only for the purpose of obtaining workable and placeable mixtures. For Class AA Concrete containing the maximum permissible water, the potential voids resulting from evaporation of the excess water would be 2.02 cubic feet per cubic yard (0.075 m^3 per m^3) of concrete. For modified mixtures proportioned for a water cement-ratio of 0.30, the voidages due to evaporation of the water in excess of that required for normal hydration of the cement would be 0.60 cubic feet per cubic yard (0.022 m^3 per m^3) of concrete.

The Class AA Concrete for Span 1 was conventionally plant batched and transit mixed in quantities of 8 to 9 cubic yards (6.1 to 6.9 m^3) per load. Wax beads for concrete for Span 2 were weighed and fed manually onto the conveyor belt along with the aggregates. Transit mixing and delivery procedures were similar to those for the conventional concrete. Concretes for Spans 3 and 4 were dry batched at the plant and dry mixed in the transit-mix trucks until arrival at the bridge site. At the site, water was added; and after thorough mixing, the desired quantity of water-reducing admixture was added and mixed. For Span 3, a precalculated quantity of 40-percent aqueous solution of PVP was added and mixed to produce concrete having a slump of 3 inches (76.2 mm) and water-cement ratio of 0.30. The same procedure was to be used for production of concrete for Span 4, except Melment L-10 was to be used in lieu of PVP.

Instrumentation

Prior experimentation by the FHWA and others had indicated that, after curing, the concrete containing wax beads should be heated to a minimum temperature of 185 F (85 C) at a depth of 2 inches (50.8 mm) and not to exceed a temperature of 320 F (160 C) at a depth of 1/16 inch (1.6 mm) below the deck surface. For the purpose of monitoring heat-treating temperatures, iron-constantine thermocouples and accompanying wiring were installed in Span 2. After complete installation of all steel reinforcement and prior to placement of concrete, thermocouples were installed at the three locations shown in Figure 6. Each thermocouple was installed at a different depth (Figure 7).

Concreting Equipment

It has become evident that concreting equipment plays an integral part in the success or failure of low-slump and(or) low-void concretes. Equipment specifications were not incorporated in the special provisions for reconstructing Silas Creek Bridge. Following is a description of the equipment used.

The concrete was mixed and transported to the job site in transit-mix trucks varying from 8 to 9 cubic yards (6.1 to 6.9 m^3) per truck load. It was unloaded using a crane with a bucket capacity of 0.25 cubic yard (0.191 m^3) (Figure 8). The concrete was dumped ahead of the finishing machine, partially leveled with rakes, and vibrated internally with a hand-type portable vibrator. The concrete was then finished with a Gomaco machine.

The Gomaco machine is a self-propelled, rail-mounted finisher (Figure 9) which has a rotating drum, front-mounted auger, and a drag-type finishing plate (Figure 10). The only means of consolidation was the hand-type vibrator. The auger and rotating drum level the concrete without further working or consolidation. The drag-type finishing plate smooths the surface as shown in Figures 10 and 11. The surface was broom finished and sprayed with a curing compound and later covered with wetted burlap.

Construction Details

Span 1: Class AA Concrete, Control

Concrete placement began at 9:30 a.m. on June 29, 1976. Four truck loads, containing 8 to 9 cubic yards (6.1 to 6.9 m^3) each, were used for a total of 32-plus cubic yards (24.45 m^3). Slump of the initially placed concrete was 1 3/4 inches (44.5 mm) and finishing was difficult. The slump thereafter was increased to 3 inches (76.2 mm), and finishing proceeded smoothly. Air contents for concrete in Span 1 varied from 3.7 to 4.5 percent and averaged 4.2 percent. Consolidation of the concrete was achieved by internal vibration. The surface was broom finished, initially cured with curing compound, and later cured with wetted burlap (Figures 12 and 13). Work was completed about noon that day.

Span 2: Wax Bead Concrete

Concreting in Span 2 began at 1:30 p.m. on June 29, 1976 (Figure 14). Slumps were 2 to 3 inches (50.8 to 76.2 mm), and air contents ranged from 2.0 to 2.8 percent. No unusual difficulties were encountered, and all concrete exhibited excellent workability. The wax beads had a fluidizing effect. No unusual bleeding or signs of segregation were noted. Additional precautions were exercised in placement of concrete in the vicinity of the thermocouples and wires (Figure 15). Finishing and curing were otherwise similar to procedures used for Span 1.

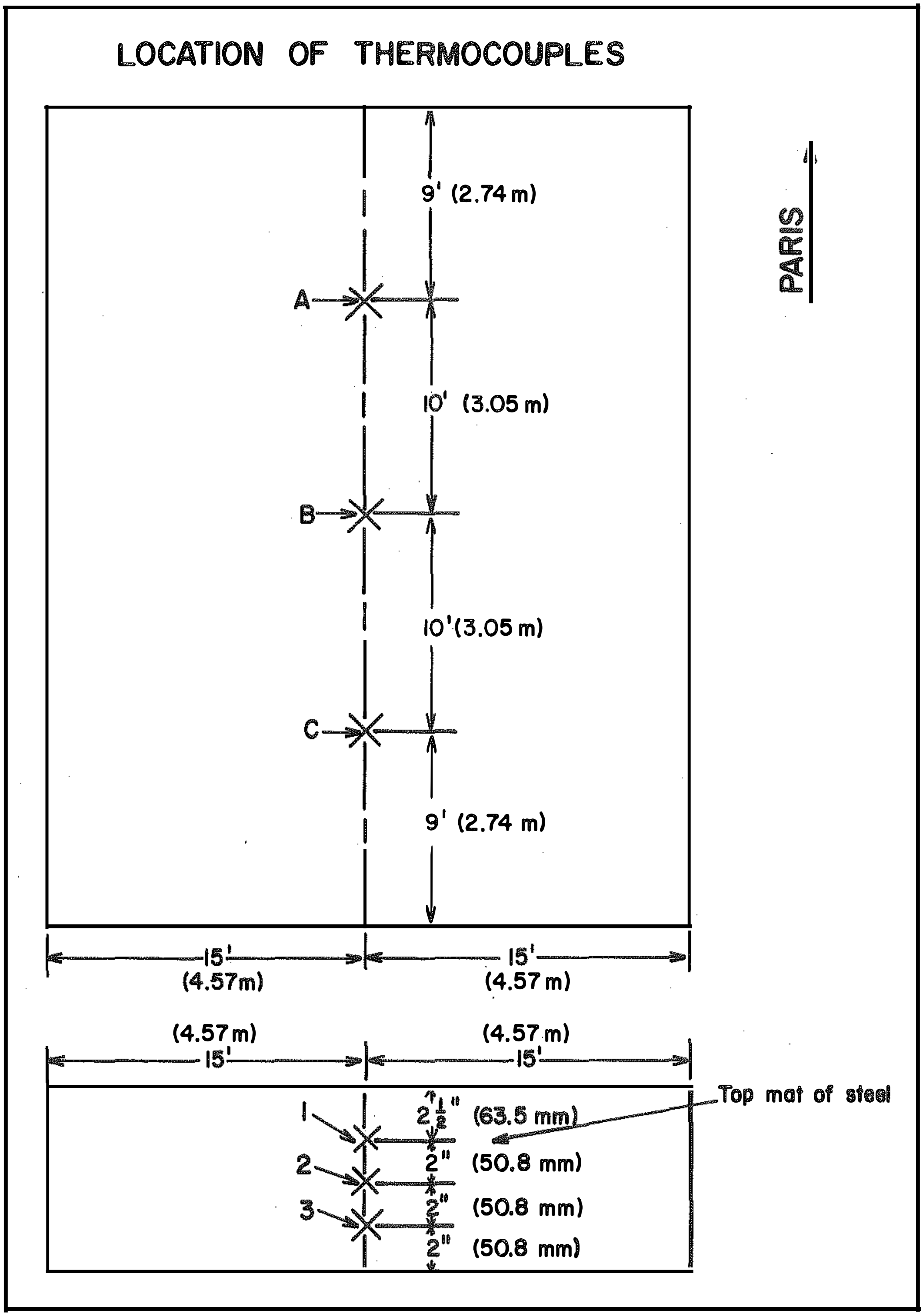


Figure 6. Location of Thermocouples in the Bridge Deck.

Figure 7. Thermocouple Installation Showing Relative Depths.

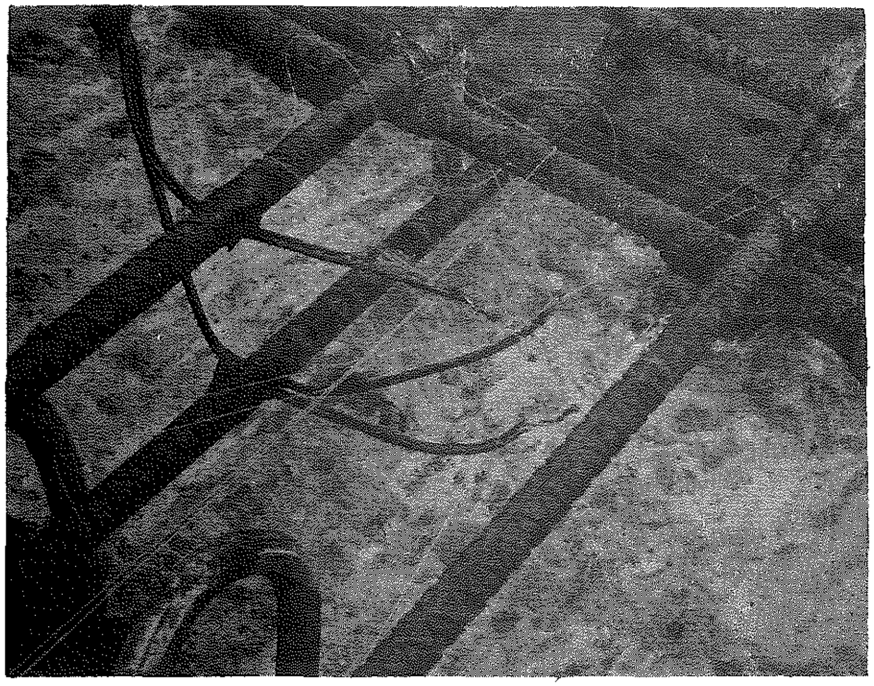
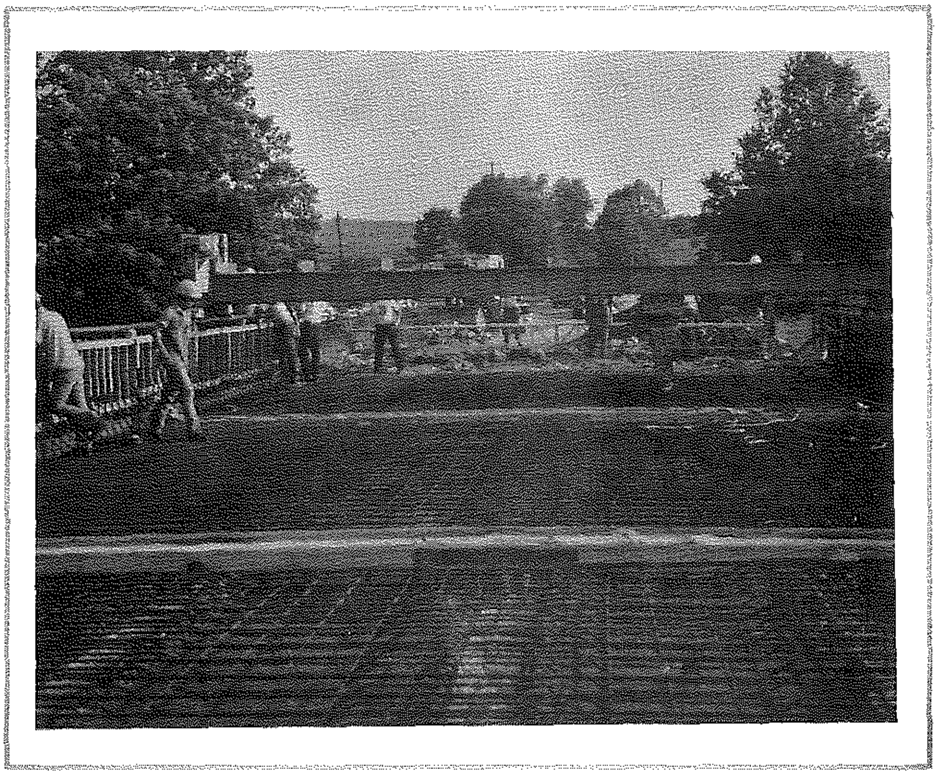


Figure 8. Bucket Used to Unload Concrete, 1/4 Cu. Yd. ($0.191\ m^3$).

Figure 9. Rail-Mounted, Gomaco Finishing Machine.



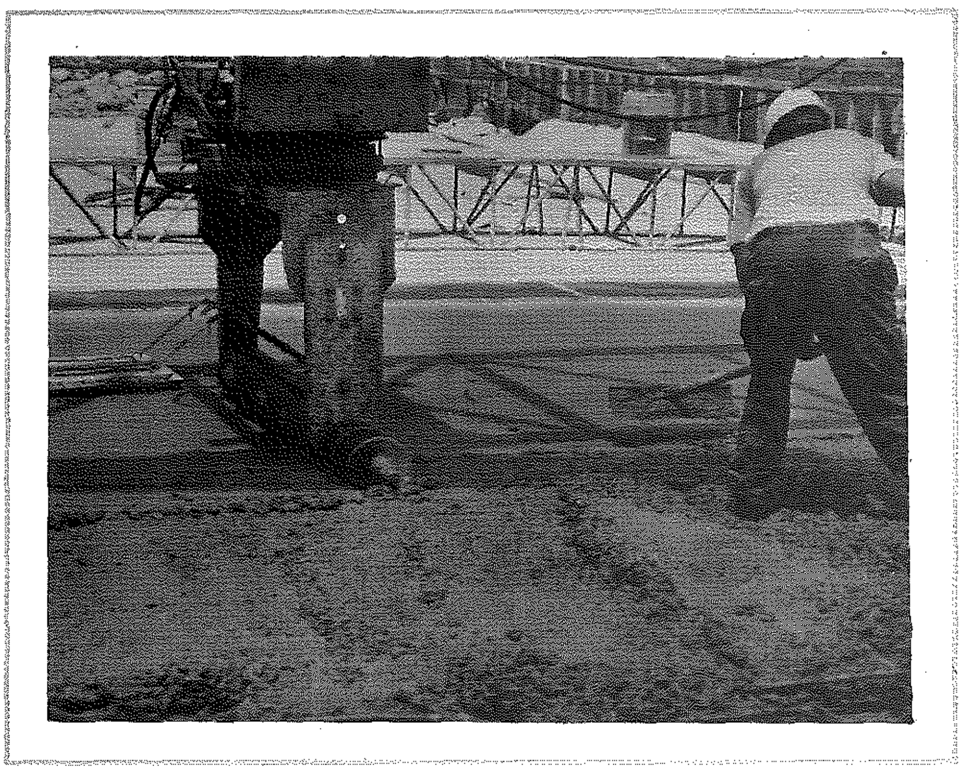
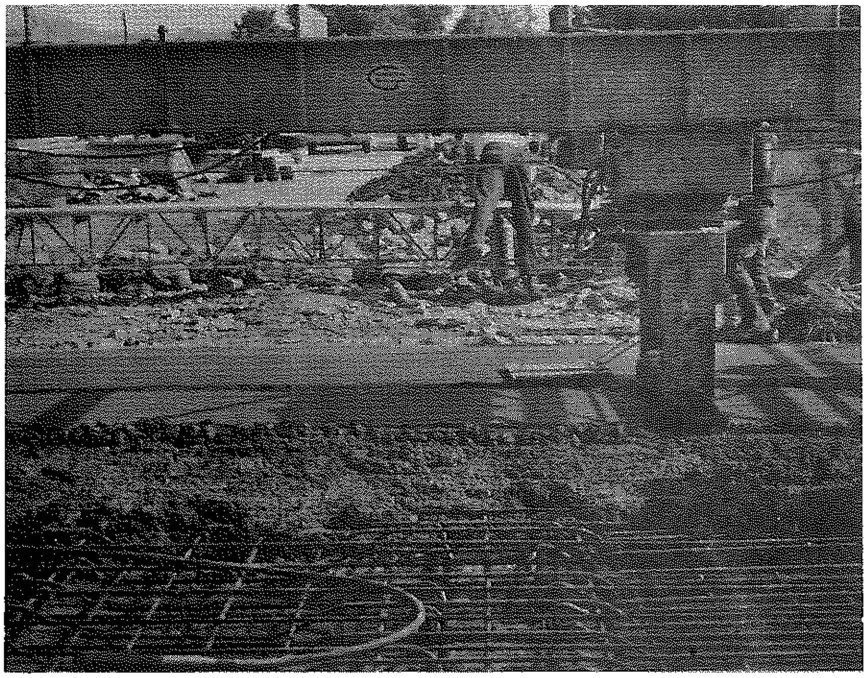


Figure 10. Finishing Drum and Auger of the Gomaco Finisher.

Figure 11. Drag Plate attached behind the Finishing Drum.



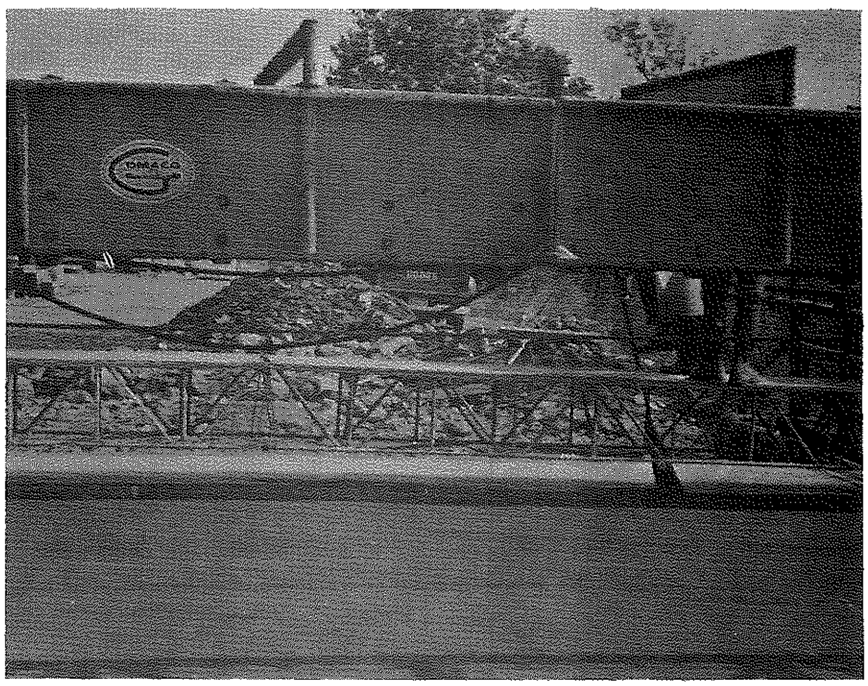
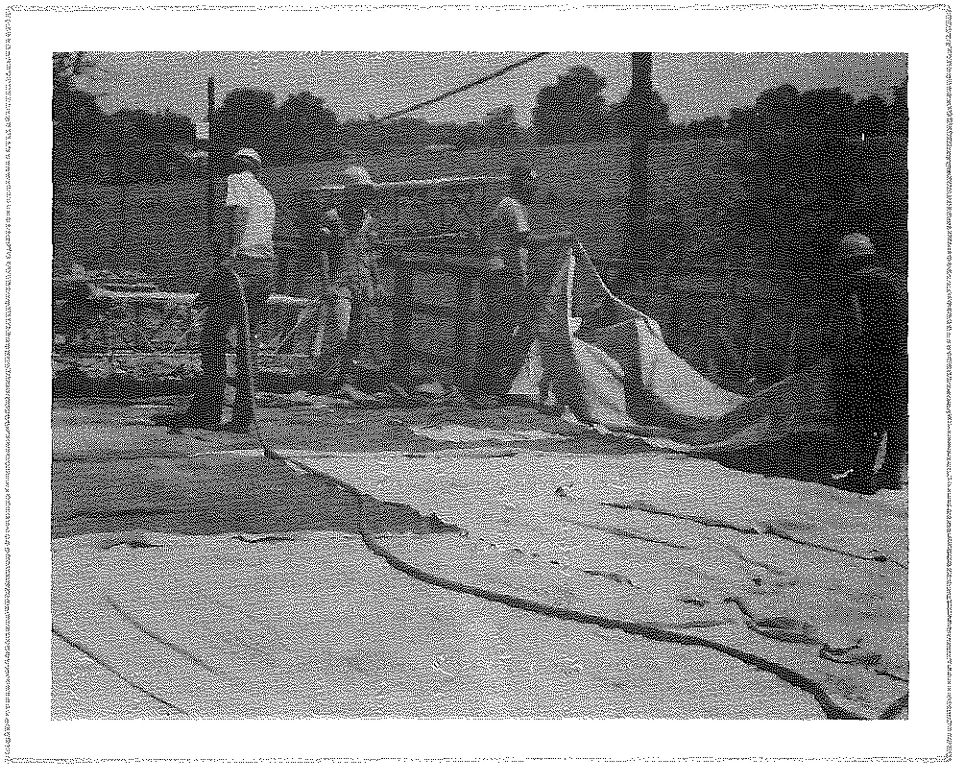


Figure 12. Broom Finishing the Surface of the Deck.

Figure 13. Curing the Bridge Deck with Wetted Burlap.



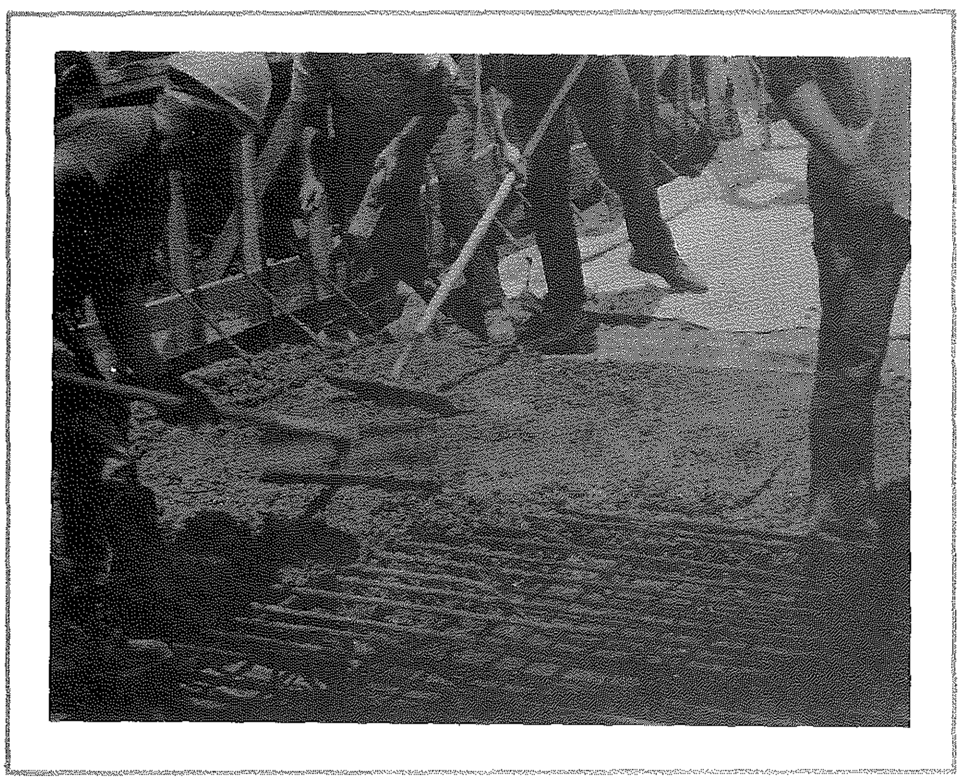
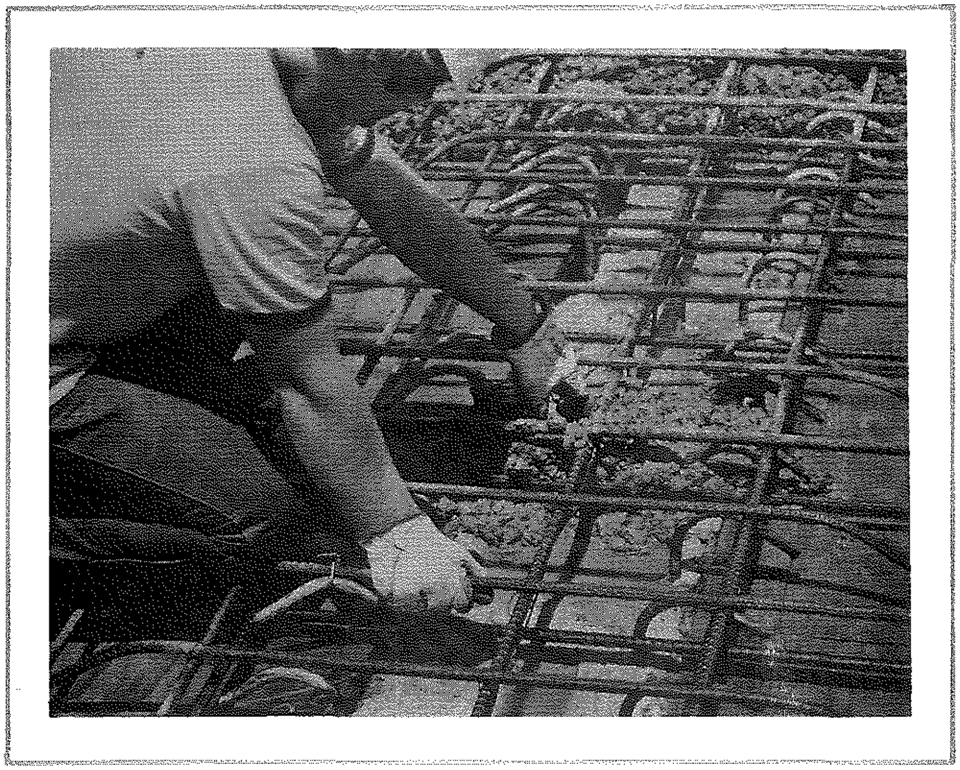


Figure 14. Placement of Wax-Bead Concrete.

Figure 15. Placing Concrete by Hand to Protect the Thermocouple Installations.



Spans 3 and 4: PVP and Melment L-10 Concrete

The PVP admixture was taken to the site very early on June 30, 1976. Due to an intense rain the night of June 29 and early morning of June 30, conditions at the site were such that concrete could not be delivered to Span 3; therefore, plans were altered; and PVP concrete was placed in Span 4.

The dry-batched loads were trucked to the site where a predetermined quantity of water was added. The constituents were thoroughly mixed and then a 40-percent aqueous solution of PVP was added; and the components were again thoroughly mixed. The resultant mixture had a water-cement ratio of 0.30 and a slump of 3 inches (76.2 mm). Unfortunately, 5 to 10 minutes after placement of the concrete was started, the mixture became stiff and could not be utilized. Several more gallons of PVP were added to the batch and the contents were remixed. The mixture remained unworkable and the contents of the first load were wasted at the site.

Similar procedures were used for other batches; however, the water-cement ratio was increased to 0.33, 0.31, and 0.32 for loads two, three, and four, respectively. The supply of PVP was depleted after placement of approximately two-thirds of the span; and Class AA Concrete was used to complete the span.

Placement of the Melment L-10 concrete in Span 3 was initiated the morning of August 1, 1976. Similar batching and mixing procedures were used for this concrete as were used for the PVP concrete. The initial consistency appeared suitable; however, after the first bucket load, slump loss was rapid and the mixture became unusable. More Melment L-10 was added but a suitable mixture could not be produced. Span 3 was completed with Class AA Concrete.

Heat Treatment of Wax Bead Concrete

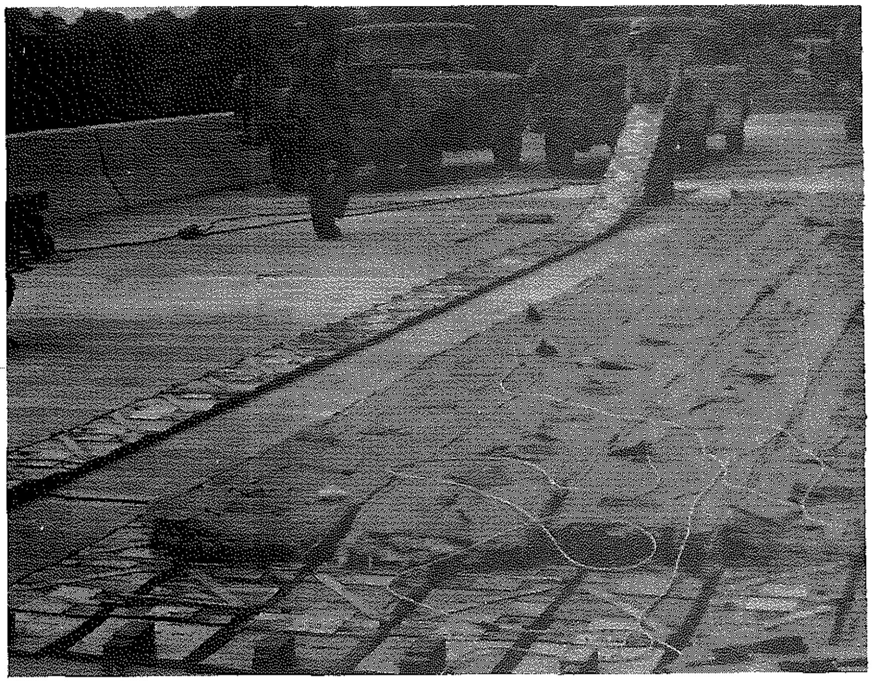
Electrical heating blankets (Figure 16) were used to heat concrete within Span 2. Treatment was initiated 21 days after placement of concrete. Fourteen, electrically grounded, hinged, and resistance-heated blankets supplied and operated by personnel from Region 15 of FHWA were used to heat the deck one lane at a time. Each blanket was 1.25 feet (0.381 m) by 48.75 feet (14.86 m) (Figure 17); they were designed and manufactured to operate from a 3-phase, 460-volt, 200-kilowatt generator. The generator (Figure 18) was a Caterpillar Model D-334 rented by the Bureau from Whayne Supply Company in Lexington, Kentucky.

Prior to placement of the heating blankets, three thermoprobes and one "hockey puck" were installed in each lane. The thermoprobes (Figure 19) were placed in 3/8-inch (9.5-mm) diameter holes drilled to a depth of 2 1/4 inches (57.2 mm). Holes were drilled at each end and at the center of the span for each lane for use in monitoring the temperature at the 2-inch (50.8-mm) depth. The "hockey puck" contained two thermostats -- one was set to illuminate an indicator at a temperature of 180 F (82 C), and the other was set to illuminate another indicator at a temperature of 300 F (149 C). The "hockey puck" was placed on the slab surface beneath the heating blankets.

After placement of the heating blankets, fiberglass insulating batting and then polyethylene sheeting were placed over the blankets (Figure 20). The objective was to heat the slab to a minimum temperature of 185 F (85 C) at the 2-inch (50.8-mm) depth and not exceed a temperature of 320 F (160 C) at the 1/16-inch (1.6-mm) depth. Heating the southbound lane began at 11:00 a.m. and ended at 11:15 p.m., July 28, 1976. Heating the opposite lane began at 11:55 p.m., July 28, and ended at 10:20 a.m., July 29, 1976. A copy of the temperature record is included in Appendix B.

Figure 16. Complete Installation of Heating Blankets over One-Lane Monitoring Unit.

Figure 17. Moving Individual Blankets in Place.



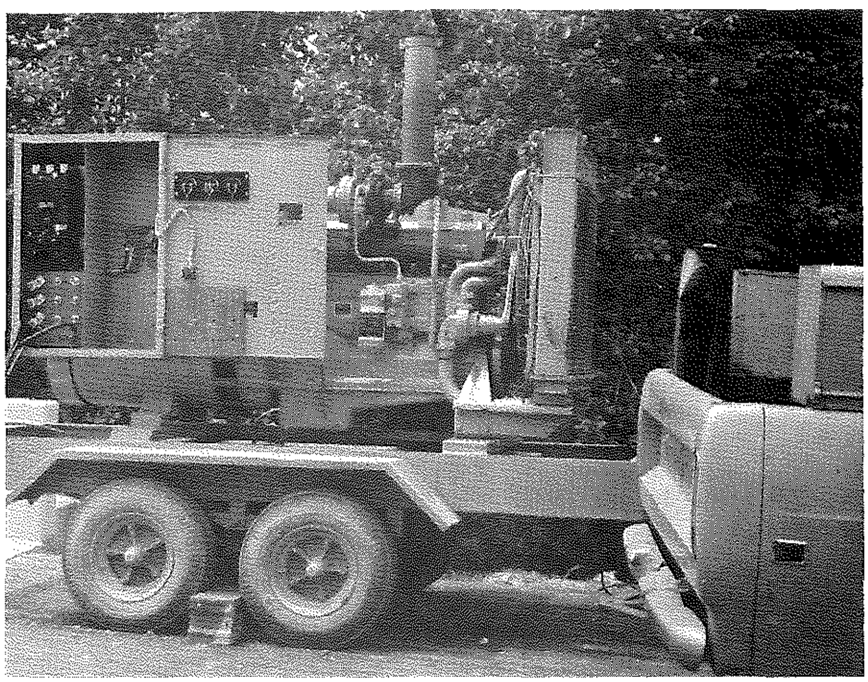
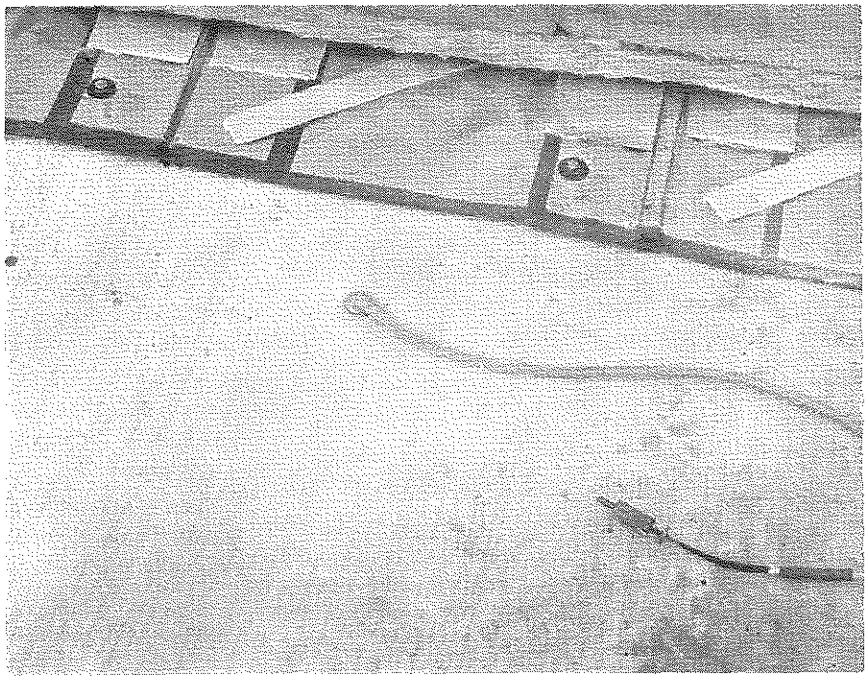


Figure 18. Diesel-Powered Generator Used to Power the Heating Blankets.

Figure 19. Thermoprobe Set in Place for Sensing Internal Temperature.



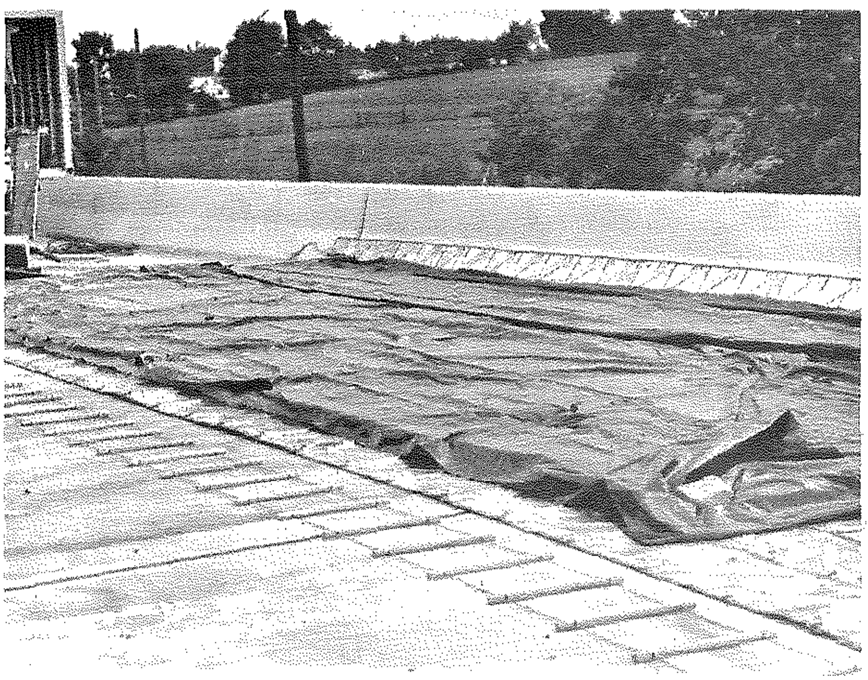


Figure 20. Blankets Covered with Insulation and Plastic to Conserve Heat and Protect against Possible Rain.

Post-Construction Tests

Upon completion of construction and after heating Span 2, cores were obtained from all spans for compressive strength, unit weight, absorption, and specific gravity determinations. In addition, cores from Span 2 were further evaluated for effects of heat treatment. Those cores were sawed longitudinally, polished, and evaluated microscopically to ascertain the extent of melting of the wax beads. It appears the wax beads were melted and dissipated into the mortar matrix from the surface to a depth of 3/4 inch (19.1 mm); however, there was no indication of melting below the 3/4-inch (19.1-mm) depth. Other data are included in Table 3. Skid-resistances are listed in Table 4.

DISCUSSION

Two major problems beset the use of low water-cement ratio concretes. The first was rapid loss of workability. Laboratory and some field work with similar mixtures indicated that the concrete would maintain a 3-inch (76.2-mm) slump for at least 20 minutes and that it would be possible to revive the slump up to 20 minutes more by adding small amounts of the water-reducing agent. The loss was drastic, however, when 8 cubic-yard (6.1 m^3) batches were attempted under field conditions. The initial setting time decreased, and the addition of PVP or Melment was only momentarily effective. This problem was compounded by the method of unloading and placing the concrete. At best, it took an average of 2 minutes to empty each bucket onto the deck while another was being filled. This means an average of 64 minutes was required to unload each 8 cubic-yard (6.1 m^3) batch of concrete. It was not possible to maintain workability of the low-slump and/or low-void mixtures for the duration of the unloading process. The second problem was associated with the finishing equipment. It might have been possible to place and finish the concrete with equipment similar to that described in the section on, "Construction Requirements, Part C of Special Provision No. 5 (76)" (Appendix C). The finishing machine, which is described there, is equipped with vibratory oscillating screeds and a vibrator every 5 feet (1.52 m) of screed length. It is also apparent that the addition of a set-retarder would have been beneficial.

Core strengths and unit weights of the PVP concrete indicate that consolidation was insufficient (Table 3). No further conclusions may be drawn until further testing is done.

TABLE 3. CONCRETE CORE TEST DATA

SAMPLE	TYPE CONCRETE	UNIT WEIGHT		COMPRESSIVE STRENGTH		SPECIFIC GRAVITY		ABSORPTION (%)
		lb/ft^3	kg/m^3	psi	kPa	SAT. SUR. DRY	APPARENT	
1	AA	148.7	2,382	5,614	38.71	2.38	2.42	1.11
2	Waxbeads	140.2	2,245	3,219	22.19	2.25	2.29	1.68
3	AA	147.2	2,358	5,352	36.90	2.36	2.44	2.42
4	PVP	143.3	2,296	2,954	20.37	2.30	2.38	2.78
5	AA	147.7	2,365	5,689	39.22	2.37	2.44	2.18
6	Waxbeads	140.7	2,254	3,668	25.29	2.26	2.31	2.06
7	AA	147.3	2,360			2.36	2.43	2.11
8	AA	148.6	2,380			2.38	2.45	1.94
9	PVP	148.5	2,380	3,301	22.76	2.38	2.43	1.58

TABLE 4. SKID RESISTANCE DATA

	SKID NUMBER	
SPAN	NORTHBOUND	SOUTHBOUND
1	50	55
2	50	50
3	56	52
4A	41	36
4B	63	53

Speed: 40 mph
Date Tested: 10-25-76
Span 1 is northernmost
Span 4 is southernmost
Span 4A is northern half
Span 4B is southern half

APPENDIX A

Special Notes for the Silas Creek Bridge

SPECIAL NOTES FOR BRIDGE DECK CONSTRUCTION
FOR
US 27 OVER SILAS CREEK, STA. 311+17
MP.009-0027-B0002

The following requirements, which may be additional, or may be requirements of the 1965 Standard Specifications or applicable Special Provisions which are restated for the purpose of emphasis, shall supersede only the conflicting requirements of all other documents which are a part of this contract.

Description:

All concrete shall be Class "AA", Special Provision No. 35-B, except as hereafter modified:

1. Span 1 — Sta. 310+41 310+79: The concrete in this span shall be unmodified.

2. Span 2 — Sta. 310+79 311+17: The concrete in this span shall be modified by substituting 2 cubic feet solid volume of Admixture A for an equal, solid volume of sand in each cubic yard.

3. Span 3 — Sta. 311+17 311+55: The concrete in this span shall be modified to include the use of Admixture B which is a powder referred to as PVP.

4. Span 4 — Sta. 311+55 311+93: The concrete in this span shall be modified to receive metered dosages of a water-reducing agent referred to as Melment.

Materials:

All ingredients, other than Admixtures A, B, and C, are those of Class "AA" Concrete and shall comply with the material requirements of section 403. Admixtures A, B, and C will be supplied entirely by the Bureau of Highways.

Admixture A: A specially formulated granular wax of which 100 percent passes the 20-mesh screen and no more than 5 percent passes the 80-mesh screen.

Admixture B: A dispersing agent which functions as a powerful water-reducing additive, referred to as PVP.

PVP is a powder which is added to a low water concrete mixture as an aqueous solution of 25-50 percent powder by weight.

Admixture C: A water-soluble plasticizer known as Melment. It is added to a concrete mixture as 20% aqueous solution.

Construction Requirements:

Proportioning:

Span 2 - The concrete* in Span 2, Sta. 310+70 311+17, shall not be air-entrained and shall be proportioned as follows:

Material	Quantity (lb/cu. yd.)	
Type I Portland Cement	620.4	
Water* (W/C = .44)	275.2	(33 gal)
Fine Aggregate*	933.3	
Coarse Aggregate*	1920.6	
Wax beads	112.9	

*The engineer will determine the actual quantities of these ingredients to be used.

Span 3 - The concrete in Span 3, Sta. 311+17 311+55, shall be air-entrained and shall be proportioned as follows:

Material	Quantity (lb/cu. yd.)
Type I Portland Cement	620.4
Water* (W/C = .3)	186.1
Fine Aggregate*	1196.0
Coarse Aggregate*	1814.0
PVP** -- 40% aqueous solution	23-30

*The Engineer will determine the actual quantities of these ingredients to be used.

**The Engineer will determine the actual quantity of this material to obtain the desired slump.

Span 4 - The concrete in Span 4, Sta. 311+55 311+93, shall be air-entrained and shall be proportioned as follows:

Material	Quantity (lb/cu. yd.)
Type I Portland Cement	620.4
Water* (W/C = .3)	186.1
Fine Aggregate*	1196.0
Coarse Aggregate*	1814.0
Melment**	15-21

*The Engineer will determine the actual quantities of these ingredients to be used.

**The Engineer will determine the actual quantity of this material in order to obtain the desired slump.

Mixing:

Span 2, Sta. 310+70 311+17:
Mixing procedure will be as follows:

(a) load dry ingredients
(b) add wax beads
(c) mix thoroughly
(d) add water and mix in conventional manner

Span 3 and 4, Sta. 311+17 311+55 and 311+55 311+93:
All ingredients should be mixed throughly before Admixtures B or C are added. The concrete is mixed in the conventional manner after the Admixtures are added.

Method of Measurement:

The volume of concrete in the completed and accepted deck will be measured in cubic yards. In computing the volume for payment, the dimensions used shall be those shown on the plans or as ordered by the Engineer.

Basis of Payment:

The accepted quantity will be paid for at the contract unit price per cubic yard for "Conventional and/or Modified Concrete", which payment shall be full compensation for all materials, equipment, labor, and incidentals necessary to complete the work in an acceptable manner.

APPENDIX B

Heat Treatment Record for Internally Sealed Concrete, Span 2

RECORD
BRIDGE DECK HEAT TREATMENT
FOR INTERNAL SEALING OF CONCRETE

Project No. & Location Silas Creek Bridge U.S. 27
Bourbon and Harrison County Line

STATE Kentucky Date 7/28/76
Heat Run No. 1

Time of Probe Light On
#1 #2 #3

Start Time 11:00 am End Time 11:15 pm

Weather & Air Temperature (At Start & Finish of Heat Run) Hazy Sun - Calm, Temp. 24°C

Clock Time (Hr. & Min)	Heat Run Elapsed Hours To Tenths	Hockey Puck Temperature Direct	Direct	1/16" Surface F°	Yellow Temp. 2" Depth Probe #1 C°	F°	F° Corrected	Blue Temp. 2" Depth Probe #2 C°	F°	F° Corrected	Green Temp. 2" Depth Probe #3 C°	F°	F° Corrected	Remarks & Auxiliary Temperature Data Readings
11:00	0.0	24			24			24			24			440 V @ 54 H
11:30	0.5	62			30			32			30			90A @ 430V Ambit 27°C
12:00	1.0	71			35			37			36			Moved Volts to 470 @ 98A
12:20	1.3	79			39			41			40			Generator off 5-8 min. To adjust governor.
12:30	1.5	75			40			43			41			Volts to 480 @ 98A, 61.2 H Air 29°C
1:00	2.0	87			46			48			46			Volts 480 @ 98A, 61.2 H Air 29°C
1:30	2.5	91			51			54			52			Volts 480 @ 98A, 61.2H Air 29°C
2:00	3.0	94			54	129	129	57	103	103	56	101	101	Volts 480 @ 98A, 61.6H Air 29°C
2:30	3.5	95			57	103	103	59	138	136	58	136	135	Volts 465 @ 96 A, 59.6H Air 29°C
3:00	4.0	98			59			63			61			Volts 470 @ 98A, 61 H Air 29°C
3:30	4.5	102			62			66			64			Volts 475 @ 96A, 61H Air 30°C
4:00	5.0	104	219	191	65			68			67			Volts 470 @ 97A, 61H Air 30°C
4:30	5.5	107			67			71			69			Volts 470 @ 98A, 61H Air 33°C
5:00	6.0	110	230	198	70			74			72			Volts 470 @ 98A, 61H Air 30°C
5:30	6.5	112			72			76			75			Volts 470 @ 97A, 61H Air 30°C
6:00	7.0	114			74			78			77			Volts 470 @ 97A, 61H Air 31°C
6:30	7.5	117			76	169	155	80	176	162	79	174	160	Volts 470 @ 96A, 61H Air 29°C
7:00	8.0	119			79			83			81			Volts 470 @ 96A, 61H 29°C
7:30	8.5	122			81			88			84			Volts 470 96A, 61H 29°C
8:00	9.0	123			82			91			85			Volts 470 96A, 61H 28°C
8:30	9.5	125			84			94			87			Volts 470 96A, 61H 27°C
9:00	10.0	127			87			98			90			Volts 470 95A, 61H 25°C
9:30	10.5	128			88			100			91			Volts 470 @ 98A, 61H 25°C
10:00	11.0	130			89			98			93			Volts 470 @ 98A, 61H Air 23°C
10:30	11.5	132			91			102			94			470 Volts @ 96A, 61H Air 23°C
11:00	12.0	133			92			104			96			470 Volts @ 96A, 61H Air 23°C
11:15	12.25	134	273	248	93	199	185	105	221	207	97	207	193	470 Volts @ 96A, 61H Air 23°C

RECORD
BRIDGE DECK HEAT TREATMENT
FOR INTERNAL SEALING OF CONCRETE

Project No. & Location Silas Creek Bridge U.S. 27 Bourbon and Harrison County Line

STATE Kentucky Date 7/28/76

Time of Probe Light On #1____ #2____ #3____

Heat Run No. 2

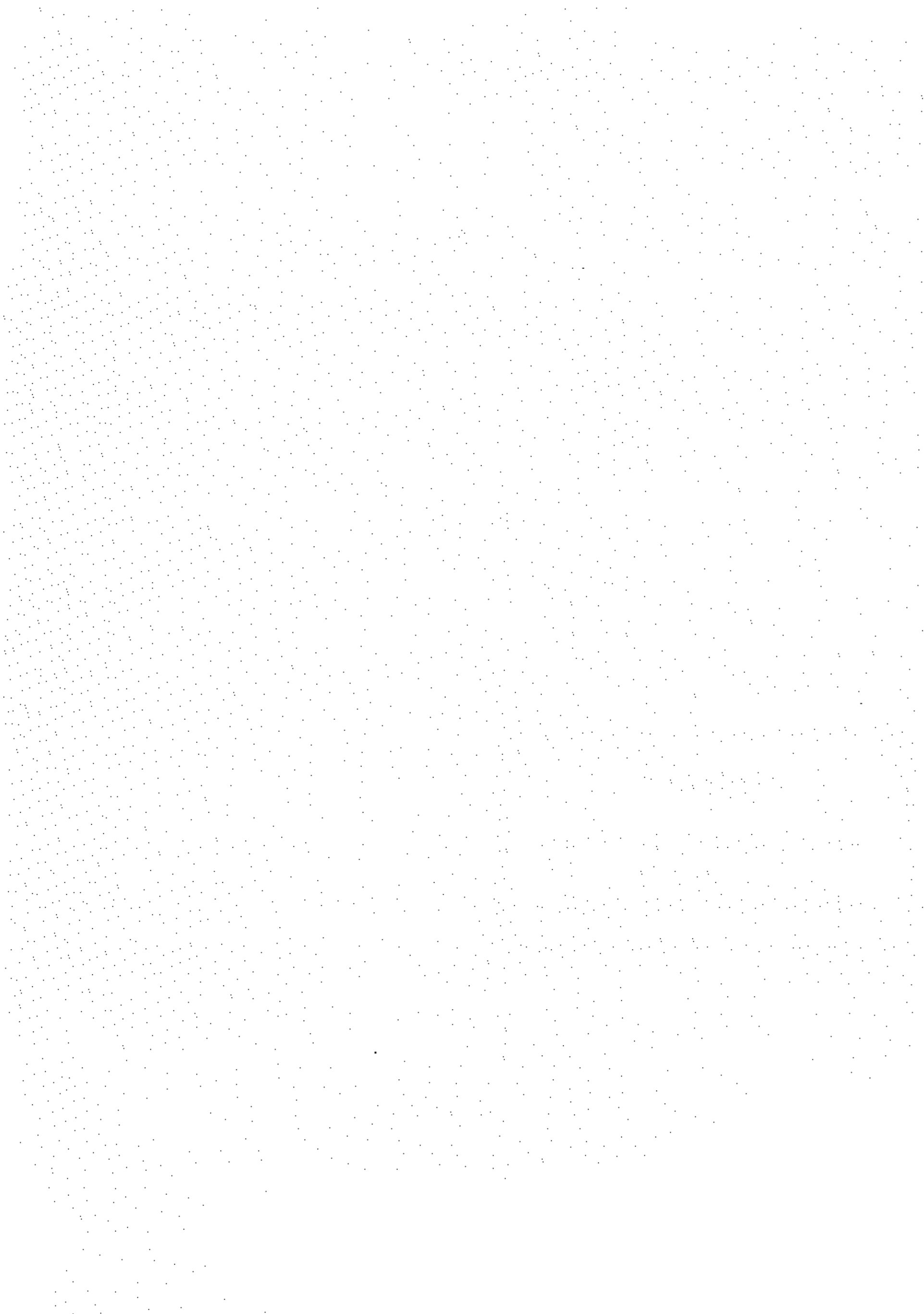
Start Time 11:55 pm End Time 10:20 am

Weather & Air Temperature (At Start & Finish of Heat Run) ________

Clock Time (Hr.&Min)	Heat Run Elapsed Hours To Tenths	Hockey Puck Temperature Direct	Direct	1/16" Surface F°	Yellow Temp. 2" Depth Probe #1 C°	F°	F° Corrected	Blue Temp. 2" Depth Probe #2 C°	F°	F° Corrected	Green Temp. 2" Depth Probe #3 C°	F°	F° Corrected	Remarks & Auxiliary Temperature Data Readings
11:55	0	34			25			28			29			Volts 480 99A 61.6 Hz Air 23°C
12:25	0.5	82			43			36			38			Volts 480 97A 61.9 Hz Air 22°C
12:55	1.0	87			46			39			42			Volts 480 97A 61.9 Hz Air 23°C
1:15	1.3	77			48			42			45			Volts 480 99A 61.8 Hz Air 22°C
1:25	1.5	93			50			44			47			Volts 480 97A 62 Hz Air 22°C
1:55	2.0	101			52			48			51			Volts 480 97A 62 Hz Air 23°C
2:25	2.5	105			55			52			55			Volts 480 98A 62 Hz Air 23°C
2:55	3.0	109			61			55			59			Volts 480 97A 62 Hz Air 23°C
3:25	3.5	112			66			59			62			Volts 480 97A 62 Hz Air 22°C
3.55	4.0	115			68			61			65			Volts 480 98A 62 Hz Air 22°C
4.25	4.5	117			73			64			68			Volts 480 98A 62 Hz Air 22°C
4.55	5.0	120			76			66			70			Volts 480 98A 62 Hz Air 21°C
5.25	5.5	122			78			69			73			Volts 480 98A 62 Hz Air 21°C
5.55	6.0	124			81			71			75			Volts 480 98A 62 Hz Air 20°C
6.25	6.5	126			85			74			78			Volts 480 97A 62 Hz Air 20°C
6.55	7.0	128			88			76			80			Volts 480 98A 62 Hz Air 20°C
7.25	7.5	130			91			78			83			Volts 480 98A 62 Hz Air 21°C
7.55	8.0	132			95			80			85			Volts 480 98A 62 Hz Air 21°C
8.25	8.5	134			99			82			87			Volts 480 98A 62 Hz Air 21°C
8.55	9.0	136			97			84			89			Volts 480 96A 62 Hz Air 22°C
9:30	9.6	138			103			87			92			Volts 480 97A 62 Hz Air 22°C
10:00	10.1	140			106			89			93			Volts 480 97A 62 Hz Air 23°C
10:20	10.4	140	284	261	108	226	212	92	198	184	95	203	189	Volts 480 97A 62 Hz Air 23°C
			Shut off the		Generator									

APPENDIX C

Special Provision No. 5 (76)
for
Concrete Bridge Deck Overlays



KENTUCKY DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
SPECIAL PROVISION NO. 5 (76)

CONCRETE BRIDGE DECK OVERLAYS

This Special Provision will apply to a project when indicated on the plans or in the proposal. Section references herein are to the Bureau's 1976 Standard Specifications for Road and Bridge Construction.

I. DESCRIPTION

This work shall consist of the construction of a latex concrete overlay or a portland cement concrete overlay, as applicable, on an existing concrete bridge deck and shall include the furnishing of all labor, materials, and equipment necessary to blast clean the existing deck and to place, finish, and cure the overlay.

II. MATERIALS

All materials shall be approved prior to use.

The moisture content of the aggregates, especially the fine aggregate, shall be controlled by the Contractor so that, at the time of mixing, the moisture content of each aggregate is relatively uniform; the material will feed uniformly when continuous type mixers are used; and the moisture content of the aggregates is not so great that the water-cement ratio or slump requirement for the concrete mixture are violated. Any concrete mixture produced which is not properly proportioned or is not in reasonably close conformity with the specified slump and/or water-cement ratio will be rejected by the Engineer, and shall be replaced with concrete mixture meeting the requirements of this Special Provision at no cost to the Bureau. When the water-cement ratio or slump requirements are violated due to excessive moisture content of the aggregate, this condition shall be corrected by the Contractor at his expense before mixing operations are continued.

Cement--The cement shall be Type I Portland Cement conforming to the requirements of Section 801.

Water--The water shall conform to the requirements of Section 803.

Fine Aggregate--The fine aggregate for the concrete mixtures shall be natural sand conforming to the requirements of Section 804.03 and shall be stored and handled as specified in Section 601.03. The Engineer will determine the moisture content of the natural sand in order to calculate its free water content and the resulting water-cement ratio of the concrete mixtures.

Coarse Aggregate--Coarse aggregate for the concrete mixtures shall be size No. 9M conforming to the requirements of subsection 805.04.01. The Engineer will determine the moisture content of the coarse aggregate in order to calculate its free water content and the resulting water-cement ratio of the concrete mixtures.

Air-Entraining Admixture--Air-entraining admixture used in portland cement concrete overlays shall conform to the requirements of subsection 802.01.01.

Water-Reducing Admixture--The water reducing admixture used in portland cement concrete overlays shall conform to the requirements of subsection 802.01.02 or 802.01.03.

Epoxy-Sand Slurry--All materials for the epoxy-sand slurry shall conform to the requirements of the current edition of Special Provision No. 6 (76).

Sand For Grout--Sand used in the grout-bond coat for portland cement concrete overlay shall be mortar sand conforming to the requirements of Section 804.05.

Latex--The latex admixture for the concrete mixture shall be a product on the list of approved products on file at the Bureau's Division of Materials. In order for a product to be placed on the list, it shall meet all requirements herein.

The latex admixture shall be a material which is produced in the United States by a company recognized as an established manufacturer of chemical products.
The latex admixture shall be one which is thoroughly described in brochures issued by the manufacturer and which is recommended specifically for latex concrete mixtures to be used as overlays on portland cement concrete bridge decks. The brochure shall contain recommended practices and procedures for each facet of the work necessary to provide for a uniform, dense, tightly-bonded, durable overlay on bridge decks.

Latex concrete specimens for determining compressive strength, flexural strength, absorption, bond strength, and any other properties the Bureau may deem necessary will be prepared by the Bureau's Division of Materials. After the specimens have been tested, the values determined for the specimens will be compared with values previously established by the Bureau as standards for acceptance. The latex admixture will be rejected whenever any of the values for the specimens do not conform to the established values. The Division of Materials may elect to accept test results from independent testing laboratories or other governmental agencies for properties requiring either special tests or tests that need extended periods of time to perform.

An approved latex will be check sampled and tested whenever the Engineer deems advisable, and will be removed from the approved product listing at any time there is an indication of nonconformity or questionable quality.

The latex admixture shall be a uniform, homogeneous, nontoxic film-forming polymeric emulsion to which stabilizers have been added at the point of manufacture. The latex admixture shall conform to the following requirements for chemical and physical properties:

Chemical Properties

Polymer Type	Styrene Butadiene

Physical Properties

Percent solids	46 percent, minimum
Weight per gallon 25°C	8.4 lbs., minimum
Shelf Life	2 years, minimum

The latex admixture shall not contain any chlorides.

Each shipment of the latex admixture shall be accompanied by a notarized certificate from the manufacturer attesting to the material's conformance to the above chemical and physical properties. The certificate shall also state the date of manufacture of the latex admixture, batch or lot number(s), quantity represented, manufacturer's name, and the location of the manufacturing plant.

The latex admixture shall be packaged and stored in containers and storage facilities which will protect the material from freezing and from temperatures above 85 degrees F. Additionally, the material shall not be stored in direct sunlight and shall be shaded when stored outside of buildings during moderate temperatures.

III. CONSTRUCTION REQUIREMENTS

A. General Requirements. These general requirements shall apply to both latex concrete overlays and portland cement concrete overlays.

The sequence of operations shall be: blast cleaning of the existing deck; application of the grout-bond coat; mixing, placing and consolidation of the concrete overlay mixture; finishing; texturing; curing; sealing joints and cracks; and application of the epoxy-sand slurry. The deck which is to be overlaid shall be at least 14 calendar days old before overlay operations are started.

1. *Blast Cleaning*--The entire area of the deck surface and the vertical faces of curbs, barrier walls, and plinths up to a height of 1 inch above the top elevation of the overlay shall be blast cleaned to a bright, clean appearance which is free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint, and all foreign matter. The blast cleaning of an area of the deck shall normally be performed within the 24-hour period preceding placement of the overlay on the area. The blast cleaning may be performed by either wet sandblasting, high pressure water blasting, blasting grits, shrouded dry sandblasting, or dry sandblasting with dust collectors, or other method approved by the Engineer. The method used shall be performed so as to conform with air and water pollution regulations applicable to the county or city where the site of work is located and to also conform to applicable safety and health regulations. Any method which does not consistently produce satisfactory work and conform to the above requirements shall be discontinued and replaced by an acceptable method. All debris of every type, including dirty water, resulting from the blast cleaning operation shall be reasonably confined during the performance of the blast cleaning work and shall be immediately and thoroughly cleaned from the blast cleaned surfaces and all other areas where any escaped debris may have accumulated. The blast cleaned areas shall be protected, as necessary, against contamination prior to placement of the overlay. Contaminated areas and areas exposed more than 36 hours shall be blast cleaned again as directed by the Engineer at the Contractor's expense.

2. *Mixing*--Concrete for concrete overlays shall be mixed at the work site by either batch or continuous mixers approved by the Engineer. Drum-type transit truck mixers or rotating drum batch-type mixers shall not be used in any circumstance for portland cement concrete overlays. All batch mixers shall be equipped with rotating blades or paddles. The maximum time between completion of mixing and placement shall not exceed 20 minutes.

Batch-type mixers shall be equipped with or accompanied by suitable devices for accurately measuring the weight of the cement, fine aggregate, and coarse aggregate for each batch and for accurately determining either the volume or the weight of the water, the water-reducing and air-entraining admixtures, and latex admixture, as applicable, for each batch. Approved methods for adding the air-entraining admixture and the water-reducing admixture shall be provided. The admixtures shall be kept separated, and shall be separately added to the mixture. Batch-type mixers which entrap unacceptable volumes of air in the mixture shall not be used.

Continuous-type mixers shall be equipped so that the proportions of the latex admixture (when required), cement, fine aggregate, and coarse aggregate can be fixed by calibration of the mixer and cannot be changed without destroying a seal or other indicating device affixed to the mixer by the Engineer. The latex admixture supply portion of the mixer shall be equipped with a cumulative-type meter which can be read to the nearest 0.1 of a gallon. The water supply portion of the mixer shall be equipped with a flow meter or other suitable device for calibrating the water supply, and a cumulative-type water meter which can be read to the nearest 0.1 gallon. The latex and water meters shall be readily accessible, accurate to within ± 1 percent, and easy to read. Approved methods for adding the air-entraining admixture and the water-reducing admixture, when required, shall be provided. The admixtures shall be added so as to be kept separated as far as is practicable. The continuous-type mixer shall be calibrated to the satisfaction of the Engineer prior to starting the work. It shall be recalibrated thereafter at least once during each 50 cubic yards production when yield checks indicate recalibration is necessary, and at any other times the Engineer deems necessary to ensure proper proportioning of the ingredients. Continuous-type mixers which entrap unacceptable volumes of air in the mixture shall not be used.

The mixer, whether batch or continuous-type, shall be kept clean and free of partially dried or hardened materials at all times. It shall consistently produce a uniform, thoroughly blended mixture within the specified air content and slump limits. Malfunctioning mixers shall be immediately repaired or replaced with acceptable units.

3. *Brooming and Texturing*--Immediately after finishing, the surface of the overlay shall be broomed transversly (the broom used on portland cement concrete overlays shall have relatively stiff bristles). Following brooming, the surface shall be textured in accordance with the requirements of Section 609.13.

4. *Epoxy-Sand Slurry*--After the overlay has been completed and cured, a thin coat (approximately 1/16 inch) of an epoxy-sand slurry conforming to the requirements of the current edition of Special Provision No. 6 (76) shall be applied to the 12 inches of the overlay adjacent to the curbs, concrete barrier walls, or other vertical walls. The epoxy-sand slurry mixture shall extend up the faces of the curbs and walls for 3 inches above the overlay. The areas to receive the epoxy-sand slurry shall be thoroughly blast cleaned to a clean, bright appearance and shall be thoroughly clean and dry before the slurry is applied.

5. *Unacceptable Work*--The thickness of the overlay will be determined by the Bureau in accordance with the Bureau's current procedures. Any core holes in the overlay shall be filled by the Contractor using concrete overlay material, at no additional cost to the Bureau. Areas found

to be deficient in thickness no more than 1/2 inch will be paid for as specified hereinafter. Areas found deficient by more than 1/2 inch shall be removed and replaced with concrete overlay of the specified thickness at no cost to the Bureau.

Any areas of the overlay which either display a significant number of cracks or which are not intimately bonded to the underlying deck shall be removed and replaced with acceptable concrete at the Contractor's expense. All small cracks which exist but are not significant enough to require removal of the overlay shall be thoroughly sealed with grout to the satisfaction of the Engineer.

B. Special Requirements for Latex Concrete Overlays. In addition to the General Requirements, the following shall apply to Latex Concrete Overlays.

1. Weather Limitations--Construction of the overlay shall be performed during favorable weather conditions. Preferably, the mixture shall be placed when the atmospheric temperature is between 55 degrees F and 75 degrees F, when the wind velocity is low, when the relative humidity is normal or high, and when hot conditions or rain are not expected. In all instances, the mixture shall be placed when the temperature is above 45 degrees F, and is predicted to be above 45 degrees F for at least 8 hours after the mixture is placed. The mixture shall not be placed when the temperature is 85 degrees F or higher, when the wind velocity is high, when the relative humidity is extremely low, when rain is expected during the working period, when the sun causes difficulty in finishing or texturing the overlay, or when any other atmospheric conditions cause difficulty in the satisfactory finishing, texturing, and curing of the overlay. This may require nighttime work or other limited work periods.

2. Prewetting and Grout-Bond Coat--The blast cleaned areas to receive the overlay shall be thoroughly and continuously wetted with water at least 1 hour before placement of the overlay is started. The areas shall be kept wet and cooled with the water until the overlay is placed. Any accumulations of water shall be dispersed and/or removed prior to applying the grout-bond coat. Immediately ahead of placing the overlay mixture, a thin coating of the latex concrete mixture to be used for the overlay shall be thoroughly brushed and scrubbed onto the wetted surface as a grout-bond coat. Coarser particles of the mixture which cannot be scrubbed into intimate contact with the surface shall be removed and disposed of in a manner approved by the Engineer.

The grout-bond coat shall be applied only for a short distance in advance of the placement of the overlay and shall not be allowed to show any signs of drying prior to being covered with the overlay.

3. Proportioning--The latex concrete shall be accurately proportioned as follows, and adjusted so as to contain no less than 7 bags of cement nor less than 24.5 gallons of latex admixture per cubic yard.

Material	Quantity
Type I Portland Cement	94 lb.
Latex Admixture	3.5 gal.
Fine Aggregate	225 to 265 lb.*
Coarse Aggregate	158 to 198 lb.*
Water (including free moisture on the fine and coarse aggregates)	22 lb. maximum**

** The Engineer will design the mixture and will determine the actual quantity of this ingredient to be used.*

*** The actual quantity of water to be used within this limit, shall be determined by the Contractor and shall be subject to the approval of the Engineer.*

The properties of the latex concrete shall be as follows when determined by the Bureau's current methods.

Property	Value
Slump (when continuous mixers are used, slump should be measured 4 to 5 minutes after discharge)	4 to 6 in.
Air Content	No more than 6 percent
Water-cement ratio (considering all the nonsolids in the Latex Admixture as part of the total water)	No more than 0.40
Desired compressive strength at 7 calendar days	3,000 psi.

4. Placing, Consolidating, and Finishing the Overlay--The latex concrete for the overlay shall be placed on the blast cleaned and prewetted deck immediately after the grout-bond coat has been applied. The design thickness of the overlay is 1 1/2 inches. The finishing machine shall be passed over the existing deck prior to placing the overlay so that measurements can be made to ensure that the proper cross slope and thickness will be achieved.

The top surface of the overlay shall be uniform, smooth, and even-textured after finishing by an approved finishing machine. The finishing machine shall be equipped with a vibrator positioned in advance of or attached to the screeding device, and the latex concrete shall be thoroughly consolidated by vibration during the finishing operations. The formation of longitudinal joints and transverse construction joints shall be held to the minimum necessary, and both types of joints shall be thoroughly blast cleaned and coated with grout-bond coat material before fresh mixture is placed against the hardened sides of the joints. When longitudinal joints are necessary, they shall be formed by use of a longitudinal header secured to the deck, 1/4 inch less in thickness than the overlay. The top surface of the consolidated and finished concrete overlay shall be smooth, uniform, and tight, and variations in the surface when checked with a 10-foot straightedge shall not exceed 1/4 inch.

5. Curing--Immediately following the texturing operation and as soon as the overlay will not be deformed by the added weight, the overlay shall be covered with a thoroughly wetted layer of burlap and a layer of polyethylene film 4 mils or more in thickness. The burlap and polyethylene film shall be left in place for at least 24 hours, and the burlap shall be rewetted if any signs of drying appear.

After the 24-hour period has ended, the burlap and polyethylene shall be removed and the overlay shall be allowed to cure in the ambient air for at least 72 hours before being opened to any traffic.

After the curing of the overlay has been completed, the tops of all longitudinal and transverse construction joints shall be given a thorough coating of grout of the same mix proportions as the grout-bond coat material. The coating shall be at least 2 inches wide, and shall be neatly and uniformly applied. This coating is intended to seal any minute cracks which may have developed at these locations. The grout coating applied over construction joints shall be cured by use of a double layer of burlap kept continuously wet for at least 24 hours.

C. Special Requirements for Portland Cement Concrete Overlays. In addition to the General Requirements, the following shall apply to Portland Cement Concrete Overlays.

1. *Weather Limitations*--Construction of the overlay shall be performed during favorable weather conditions. Preferably, the mixture should be placed when the atmospheric temperature is between 55 degrees F and 75 degrees F, when the wind velocity is low, when the relative humidity is normal or high, and when hot conditions or rain are not expected. In all instances, all of the concrete shall be placed and kept at a temperature above 45 degrees F for at least 96 hours after it is placed. This will require approved housing, heating, or insulation methods or combinations thereof during cold weather. The mixture shall not be placed when the temperature is 85 degrees F or higher, when the wind velocity is high, when the relative humidity is extremely low, when rain is expected within the working period, or when any other atmospheric conditions cause difficulty in the satisfactory finishing, texturing, or curing of the overlay. This may require nighttime work or other limited work periods.

2. *Grout-Bond Coat*--After the concrete surface has been blast cleaned and accepted, and immediately prior to placing the concrete overlay mixture on the deck, a thin coating of bonding grout shall be vigorously scrubbed into the dry, clean surface areas. The surface areas shall not be wetted prior to applying the grout. When the bridge deck is exposed to rain prior to application of the grout, application shall be delayed until the bridge deck has dried sufficiently to proceed, as determined by the Engineer; a minimum drying time of 4 hours will be required. The grout shall consist of equal parts, by weight, of portland cement and mortar sand, mixed with sufficient water to form a wet slurry. The consistency of the grout shall be such that it can be applied with a stiff brush or broom in a thin, even coating which will not run or puddle in low spots. Care shall be exercised to ensure that all areas of the blast cleaned deck receive a thorough, even coating of the grout and that no excess grout is permitted to collect in any areas. The grout shall be applied only for a short distance in advance of the placement of the overlay and shall not be allowed to show any signs of drying prior to being covered with the overlay. Any areas which show any signs of drying shall be thoroughly recoated with fresh grout.

3. *Proportioning*--The concrete for the overlay shall be accurately proportioned to contain 8.75 bags of cement per cubic yard and no more than 35 gallons of water per cubic yard, including free moisture on the aggregates. The Contractor shall determine the amount of water to be added to the mixture to maintain the proper slump, except that the limit of 35 gal./cu. yd. shall not be exceeded. The desired compressive strength, at 7 calendar days, is 5,000 psi.

The amount of fine aggregate and coarse aggregate for the concrete will be determined on an approximate 50-50 basis by volume by the Engineer and shall be incorporated into the concrete mixture as directed by the Engineer.

The water-reducing admixture shall be added to the concrete in accordance with the manufacturer's recommendations, or as otherwise approved in writing by the Engineer.

The Contractor shall determine the amount of air-entraining admixture to be added to the concrete mixture. The air content of the concrete as determined by KM 65-303 shall be 5 1/2 percent. A tolerance of plus or minus 1 1/2 percent from the specified air content will be allowed for occasional samples.

The slump of the concrete, as determined by KM 64-302, shall be consistently maintained at 3/4 inch. When continuous mixers are used, slump should be measured 4 to 5 minutes after discharge. A tolerance of plus or minus 1/4 inch will be permitted for occasional samples. Concrete with a slump of more than 1 inch shall not be used in any circumstance and shall be wasted at the Contractor's expense. Concrete with a slump less than 1/2 inch shall not be used unless the finishing machine can finish and consolidate the concrete in accordance with requirements specified herein.

4. *Placing and Finishing Equipment*--Equipment shall include sufficient hand tools for placement of stiff, plastic concrete and for working it down to approximately the correct elevation for striking off with a screed.

Supporting rails upon which the finishing machine travels shall be placed outside the area to be surfaced, and shall extend beyond each end of the bridge a sufficient distance to accomodate the finishing machine. Anchorage for the supporting rails shall be substantial enough to provide for rigid horizontal and vertical stability of the rails. Methods proposed for anchoring the supporting rails to the deck shall be submitted to the Engineer for approval prior to beginning the work.

The finishing machine shall be equipped with a rigid strikeoff to provide a uniform thickness of concrete in front of the screeds and with 2 oscillating screeds set accurately to the crown specified. The screeds of the finishing machine shall be of metal.

At least one oscillating screed shall be designed to thoroughly consolidate the concrete by vibration to the specified density. A sufficient number of identical vibrators shall be effectively installed on the screed so that at least one vibrator is provided for each 5 feet of screed length. The bottom face of this screed shall be at least 5 inches wide with a turned up or rounded leading edge to minimize tearing of the surface of the plastic concrete. Each screed shall have an effective weight of at least 75 pounds for each square foot of bottom face area. Each screed shall be provided with positive control of the vertical position, the angle of tilt, and the slope of the crown.

Design of the finishing machine together with appurtenant equipment shall be such that positive machine screeding of the plastic concrete will be obtained within one inch of the face of the existing curbs; the vibrating screed shall be of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and to extend at least 6 inches beyond the longitudinal edge of a previously placed section of overlay.

The finishing machine shall be capable of forward and reverse motion under positive control. Provision shall be made for raising the screeds to clear the screeded surface for traveling in reverse.

5. Placing, Consolidating, and Finishing the Overlay--The design thickness of the overlay is 2 inches. The finishing machine shall be passed over the existing deck prior to placing the concrete overlay in order that measurements can be made to ensure that proper cross slope and thickness will be achieved. Promptly after the grout-bond coat has been applied, the concrete shall be deposited on the deck, and struck off and consolidated with the finishing machine.

Consolidation using hand-held vibrators may be required when placing the mixture around steel reinforcement.

The concrete shall first be mechanically struck off at 1/4 inch or more above the specified final thickness. It shall then be mechanically consolidated by vigorous vibration to at least 98 percent of the rodded unit weight determined by ASTM C 138 and then be screeded to the specified thickness. The unit weight of the consolidated plastic concrete will be determined by nuclear gages immediately following the screeding operation. Areas of concrete of deficient unit weight shall be immediately corrected by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified unit weight, it shall be removed and replaced with acceptable concrete. Hand finishing of the consolidated concrete with a float may be required in order to produce a tight, uniform surface.

The formation of longitudinal joints and transverse construction joints shall be held to the minimum number necessary, and both types of joints shall be thoroughly blast cleaned and coated with grout-bond coat material before fresh concrete is placed against the hardened sides of the joints. When longitudinal joints are necessary, they shall be formed by use of a longitudinal header secured to the deck, 1/4 inch less in thickness than the overlay.

The top surface of the consolidated and finished concrete overlay shall be smooth, uniform, and tight, and variations in the surface when checked with a 10-foot straightedge shall not exceed 1/4 inch.

6. Curing--Curing of the overlay shall be initiated immediately after texturing. Curing shall be accompanied by use of a double layer of wetted burlap. The burlap shall be continuously and thoroughly wetted by automatic fogging or sprinkling equipment for at least 96 hours after the curing is started. Improper curing will be a basis for rejection of the concrete and nonpayment for the total cost of the rejected concrete. Curing compound will not be permitted on the overlay. After the curing of the overlay has been completed, the tops of all longitudinal and transverse construction joints shall be given a thorough coating of grout of the same consistency as the grout-bond coat material. The coating shall be neatly and uniformly applied. This coating is intended to seal any minute cracks which may have developed at these locations. The grout coating applied over construction joints shall be cured by use of a double layer of burlap kept continuously wet for at least 24 hours.

IV. METHOD OF MEASUREMENT

Blast Cleaning--The area of the deck acceptably blast cleaned prior to placing the concrete overlay, and the 12-inch width of the overlay and the 3-inch height of vertical face to receive the epoxy-sand slurry, will be measured in square yards. The blast cleaning of any longitudinal and transverse construction joints will not be measured for payment.

Concrete Overlay, Latex--The volume of latex concrete in the completed and accepted overlay will be measured in cubic yards. In computing the volume for payment, the dimensions used shall be those shown on the plans or as ordered by the Engineer. Grout used for the bond coat and crack sealing is considered incidental to the latex concrete overlay and will not be measured for separate payment.

Concrete Overlay, Portland Cement--The volume of portland cement concrete in the completed and accepted overlay will be measured in cubic yards. In computing the volume for payment, the dimensions used shall be those shown on the plans or as ordered by the Engineer. Grout used for the bond coat and crack sealing is considered incidental to the Concrete Overlay and will not be measured for separate payment.

Epoxy-Sand Slurry--The accepted epoxy-sand slurry will be measured in standard batches as specified in the current edition of Special Provision No. 6 (76). Epoxy-sand slurry used to correct areas of unacceptable texturing will not be measured for payment.

V. BASIS OF PAYMENT

Blast Cleaning--Payment for the measured areas at the contract unit price per square yard for "Blast Cleaning" will be considered full payment for all expenses associated with the blast cleaning operation.

Concrete Overlay--The accepted quantity will be paid for at the contract unit price per cubic yard for "Concrete Overlay, Latex", or "Concrete Overlay, Portland Cement", as applicable, provided, however, that for any overlay found deficient by no more than 1/2 inch, payment will be made at a reduced price as specified in the following table:

Deficiency in Thickness (inches)	Proportional Part of Contract Price Allowed (percent)
0	100.0
1/16	95.0
1/8	90.0
3/16	80.0
1/4	70.0
5/16	57.5
3/8	45.0
7/16	25.0
1/2	0.0

At the contractor's option, areas deficient in thickness by no more than 1/2 inch may be removed and replaced with concrete overlay of the specified thickness at no cost to the Bureau.

Payment at the contract unit price will be made for areas on which deficient overlay was removed, and replaced with overlay meeting all requirements specified herein.

No additional payment will be made for concrete overlay in excess of the specified thickness.

Payment for the accepted quantity at the contract unit price, adjusted as required, shall be full compensation for all materials, equipment, labor, and incidentals necessary to construct an acceptably textured concrete overlay on the prepared bridge deck.

Epoxy-Sand Slurry--Payment will be made as specified in the current edition of Special

Provision No. 6 (76).

Payment for the above listed items at the contract unit prices for the items will be considered full payment for all expenses and all incidentals which are necessary for providing a satisfactorily completed overlay ready for traffic in accordance with the Special Provisions, with the 1976 Standard Specifications, and with any additional requirements in the plans or proposal.

APPROVED 8/17/76

Geo. F. Kemper

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STATE HIGHWAY ENGINEER